STIC Search Report
EIC 2100

STIC Database Tracking Number: 129196

TO: Luke Wassum **Location: 4D41** **Art Unit : 2177** **Friday, August 06, 2004** **Case Serial Number: 10/681581**	**From: David Holloway** **Location: EIC 2100** **PK2-4B30** **Phone: 308-7794** **david.holloway@uspto.gov**

Search Notes

Dear Examiner Wassum,

Attached please find your search results for above-referenced case.
Please contact me if you have any questions or would like a re-focused search.

David

STIC EIC 2100 Search Request Form 27

129196

Today's Date: 5 August 2004

What date would you like to use to limit the search?
Priority Date: 10/8/02 Other:

Name Luke S Wassum
AU 2177 Examiner # 77895
Room # PK2 4D41 Phone 305-5706
Serial # 10/681581

Format for Search Results (Circle One):
PAPER DISK EMAIL
Where have you searched so far?
USP DWPI EPO JPO ACM IBM TDB
IEEE INSPEC SPI Other

Is this a "Fast & Focused" Search Request? (Circle One) YES NO
A "Fast & Focused" Search is completed in 2-3 hours (maximum). The search must be on a very specific topic and meet certain criteria. The criteria are posted in EIC2100 and on the EIC2100 NPL Web Page at http://ptoweb/patents/stic/stic-tc2100.htm.

What is the topic, novelty, motivation, utility, or other specific details defining the desired focus of this search? Please include the concepts, synonyms, keywords, acronyms, definitions, strategies, and anything else that helps to describe the topic. Please attach a copy of the abstract, background, brief summary, pertinent claims and any citations of relevant art you have found.

A system to model contamination incidents in a food supply chain, including:

a product distribution database containing distribution data related to the flow of particular food products from producers to retailers to consumers

a modeling system to recieve a selected product type and model an evolving contamination incident according to the distribution data in the product distribution database and the selected product type.

STIC Searcher David Holloway Phone 308-7799
Date picked up 8-6-04 Date Completed 8-6-04

DT 1600
WWW

```
Set     Items   Description
S1          8   EPIDEMIOL?(2N)(MODEL?)(4N)(FOODBORNE? OR FOODBOURN? OR FOO-
             D()(BORN? OR BOURNE?))
S2          6   RD (unique items)
S3          6   S2 NOT PY>2002
S4          6   S3 NOT PD>20021008
File 636:Gale Group Newsletter DB(TM) 1987-2004/Aug 06
         (c) 2004 The Gale Group
File 156:ToxFile 1965-2004/Aug W1
         (c) format only 2004 The Dialog Corporation
File  98:General Sci Abs/Full-Text 1984-2004/Jul
         (c) 2004 The HW Wilson Co.
File  88:Gale Group Business A.R.T.S. 1976-2004/Aug 05
         (c) 2004 The Gale Group
File  73:EMBASE 1974-2004/Aug W1
         (c) 2004 Elsevier Science B.V.
File  51:Food Sci.&Tech.Abs 1969-2004/Aug W2
         (c) 2004 FSTA IFIS Publishing
File  16:Gale Group PROMT(R) 1990-2004/Aug 06
         (c) 2004 The Gale Group
File   5:Biosis Previews(R) 1969-2004/Aug W1
         (c) 2004 BIOSIS
```

4/5/2 **(Item 1 from file: 156)**
DIALOG(R)File 156:ToxFile

02773738 NLM Doc No: 2665178
[The contaminated chocolate epidemic of 1987]
Sjokoladeepidemien i 1987.
Kapperud G; Lassen J; Aasen S; Gustavsen S; Hellesnes I
Journal Name: Tidsskrift for den Norske laegeforening (NORWAY)
Pub. Year: Jun 30 1989 109 (19-21) p1982-5, ISSN: 0029-2001
Journal Code: 0413423
Document type: Journal Article ; English Abstract
Languages: NORWEGIAN
Main Citation Owner: NLM
Record type: Completed
Subfile: Toxbib ; INDEX MEDICUS
The article describes a nationwide outbreak of Salmonella typhimurium infection in 1987 caused by contaminated chocolate products from one particular factory. A total of 349 bacteriologically verified cases were recorded. It was estimated, however, that 20,000-40,000 persons became ill during the outbreak. We describe the epidemiological and bacteriological investigations which led to identification of the source of infection, and discuss two **epidemiological models** for investigation of **food - borne** outbreaks. The article emphasizes the importance of collaboration between the community health service and the local food inspection laboratories during investigation of foodborne outbreaks.
Tags: Female; Human; Male
Descriptors: *Cacao; *Candy; *Plants, Edible; *Salmonella Food Poisoning --epidemiology--EP; Adolescent; Adult; Aged; Child; Child, Preschool; Infant; Middle Aged; Norway; Salmonella typhimurium --isolation and purification--IP
Record Date Created: 19890822
Record Date Completed: 19890822

4/5/4 **(Item 1 from file: 73)**
DIALOG(R)File 73:EMBASE

10976008 EMBASE No: 2001014518
The use of epidemiological data to direct resources in food safety control
Powell S.C.; Attwell R.W.
Dr. R.W. Attwell, Department of Biological Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD United Kingdom
AUTHOR EMAIL: r.w.atwell@mmu.ac.uk
Reviews on Environmental Health (REV. ENVIRON. HEALTH) (Israel) 2000 , 15/4 (381-387)
CODEN: REVHA ISSN: 0048-7554
DOCUMENT TYPE: Journal ; Article
LANGUAGE: ENGLISH SUMMARY LANGUAGE: ENGLISH
NUMBER OF REFERENCES: 23

In the United States, foodborne disease results in financial losses estimated at $2.9 to $6.7 billion annually as a result of illness that is due to six specific **foodborne** pathogens. A **model** is proposed that analyzes **epidemiological** data and highlights areas in food safety control that have the greatest impact on foodborne disease. The model identifies Critical Control Points for use by the food industry, prioritizes criteria for inspection of food processes by regulatory authorities, and provides a focus for food hygiene training programs and campaigns. The model also provides a cost-benefit analysis that can be used to direct resources that are used in food safety control in a cost-effective manner.

```
Set     Items   Description
S1     812538   CROP OR CROPS OR HARVEST OR FOOD OR VEGETABLE? OR MEAT? OR
              POTATO? OR AGRICULTUR?
S2    3583652   TRACK? OR TRACE? OR MONITOR? OR MODEL? OR SIMULAT? OR PRED-
              ICT? OR FORECAST? OR SURVEILL?
S3    2045757   SPREAD? OR SUPPLY()CHAIN? OR DISTRIBUT? OR FLOW? ? OR ROUT-
              E?
S4    5891120   DISEASE? OR ILLNESS? OR ANTHRAX? OR PLAGUE? OR CONTAMINANT?
               OR POISON? OR PATHOGEN? OR SMALLPOX?
S5       3663   S1 AND S2 AND S3 AND S4
S6        754   S1(2N)S4 AND S5
S7      66255   BIOTERROR? OR BIOLOGICAL()(WEAPON? OR WARFARE?) OR FOOD()(-
              SECURIT? OR SAFE?)
S8        206   S6 AND S7
S9        188   RD (unique items)
S10       161   S9 NOT PY>2002
S11    173253   (S1 OR S4)(2N)S2
S12     33991   (S1 OR S4)(2N)S3
S13     73862   COMPUTER()(MODEL? OR SIMULAT? OR FORECAST? OR PREDICT?)
S14        70   S10 AND (S11 OR S12 OR S13)
File  51:Food Sci.&Tech.Abs 1969-2004/Aug W2
         (c) 2004 FSTA IFIS Publishing
File  63:Transport Res(TRIS) 1970-2004/Jul
         (c) fmt only 2004 Dialog Corp.
File  79:Foods Adlibra(TM) 1974-2002/Apr
         (c) 2002 General Mills
File  73:EMBASE 1974-2004/Aug W1
         (c) 2004 Elsevier Science B.V.
File 155:MEDLINE(R) 1951-2004/Aug W1
         (c) format only 2004 The Dialog Corp.
File 587:Jane`s Defense&Aerospace 2004/Jul W4
         (c) 2004 Jane`s Information Group
```

14/5/4 (Item 4 from file: 51)
DIALOG(R)File 51:Food Sci.&Tech.Abs

00863805 2002-Cf0919 SUBFILE: FSTA
The use of food **consumption data in assessments of exposure to** food **chemicals including the application of probabilistic** modelling .
Lambe, J.
Inst. of European Food Studies, Biotech. Inst., Trinity Coll., Dublin 2, Republic of Ireland. Fax +353 1 670 9176. E-mail iefs(a)iefs.ie
Proceedings of the Nutrition Society 2002 , 61 (1) 11-18
NOTE: 47 ref.
DOCUMENT TYPE: Journal Article ISSN: 0029-6651
LANGUAGE: English
Extension of the use of **food** consumption data and data on nutrient intake (collected in various surveys) to **food** chemical intakes is discussed. Chemicals for which exposure assessments are required include **food** additives, pesticide residues, environmental **contaminants** , mycotoxins, novel **food** ingredients, packaging material migrants, flavourings and micronutrients. **Monitoring** exposure to such chemicals has become an integral part of the **food safety** procedure. Aspects discussed in this paper include: sources of **food** consumption data used in exposure assessment; fitness-for-purpose (chronic vs. acute exposure, population groups, **food** groups, data quality and quantity); approaches to **modelling food** consumption in exposure assessments (point estimates, simple **distributions** , probabilistic **models**); **food** consumption data in probabilistic **models** ; and future directions. [This paper was presented at the symposium on Nutritional Aspects of **Food Safety** , held in Coleraine, UK, on 20-22 June, 2001.]
DESCRIPTORS (HEADINGS): DIET; **FOOD SAFETY** ; RESIDUES
DESCRIPTORS: CHEMICALS; RISKS ASSESSMENT
SECTION HEADINGS: Hygiene & toxicology (SC=c, 9201-present)

14/5/16 **(Item 16 from file: 51)**
DIALOG(R)File 51:Food Sci.&Tech.Abs

00832194 2001-Cd1171 SUBFILE: FSTA
Importance of predictive **microbiology for risk minimization in** food **production processes. I.** Model **creation, user programs and validating.**
Kleer, J.; Hildebrandt, G.
Inst. fuer Lebensmittelhygiene, Freie Univ. Berlin, D-14163 Berlin, Germany. E-mail jkleet(a)vetmed.fu-berlin, Germany
Fleischwirtschaft 2001 , 81 (6) 99-103
DOCUMENT TYPE: Journal Article ISSN: 0015-363X
LANGUAGE: German SUMMARY LANGUAGE: English
Predictive microbiology is discussed with reference to: basic principles; mathematical **modelling** of behaviour of microorganisms in foods in relation to intrinsic and extrinsic factors; growth, death and survival **models** for the main **pathogens** ; available software (**Food** MicroModel and **Pathogen Modelling** Program); performance of mathematical **models** used for **predictive** microbiology; application (after validation for the specific **food**) at all stages of **food** production and **distribution** ; use of **predictive** microbiology in HACCP; and use in microbiological risk assessment.
DESCRIPTORS (HEADINGS): **FOOD SAFETY** ; HACCP; MICROBIOLOGY
DESCRIPTORS: **PREDICTIVE** MICROBIOLOGY
SECTION HEADINGS: Hygiene & toxicology (SC=c, 9201-present)

14/5/37 (Item 37 from file: 51)
DIALOG(R)File 51:Food Sci.&Tech.Abs

00699341 95-09-c0005 SUBFILE: FSTA
Predictive **microbiology in a dynamic environment: a system theory approach.**
Impe, J. F. van; Nicolai, B. M.; Schellekens, M.; Martens, T.; Baerdemaeker, J. de
Fac. of Agric. & Applied Biol. Sci., Katholieke Univ. Leuven, B-3001 Leuven, Belgium. Tel. (+32)16/321466. Fax (+32)16/321997. E-mail jan.vanimpe(a)esat.kuleuven.ac.be
International Journal of Food Microbiology 1995 , 25 (3) 227-249
NOTE: 23 ref.
DOCUMENT TYPE: Journal Article ISSN: 0168-1605
LANGUAGE: English
Factors influencing the microbial stability of chilled prepared **food** products include temp., pH and aw. Unlike pH and aw, temp. may vary extensively throughout the production and **distribution** chain. Shelf life of these kinds of foods is usually limited due to spoilage by common microorganisms and the increased risk of **food pathogens** . Mathematical **models** are often used to **predict** shelf life; however, the **predictive** value of sigmoidal functions to describe a bacterial growth curve as an explicit function of time is only guaranteed at constant temp. within the temp. range of microbial growth. As a result, these **models** are less appropriate in optimization studies of a whole production and **distribution** chain. A more general **modelling** approach, inspired by system theory concepts, is presented taking into account time varying temp. profiles. A recently proposed dynamic **model** to **predict** microbial growth and inactivation under time varying temp. conditions from a system theory point of view is discussed. The validity of this methodology is illustrated with experimental data of Brochothrix thermosphacta and Lactobacillus plantarum. Some possible refinements of this **model** , inspired by experimental results, are proposed. (From En summ.) (JCM)
DESCRIPTORS (HEADINGS): Microorganisms; **Food safety** ; Microbiological techniques
DESCRIPTORS: **PREDICTIVE MODELLING** ; FOODS
GENERAL DESCRIPTORS: Microorganisms
SECTION HEADINGS: Hygiene & toxicology (SC=c, 9201-present)

14/5/44 (Item 44 from file: 51)
DIALOG(R)File 51:Food Sci.&Tech.Abs

00661625 93-07-c0061 SUBFILE: FSTA
The Food **Micromodel for** prediction **of growth of foodborne** pathogens .)
Gorris, L. G. M.; Peck, M. W.
DLO-Inst. voor Agrotech. Onderzoek (ATO-DLO), Wageningen, Netherlands
Voedingsmiddelentechnologie 1993 , 26 (5) 36-37, 39
NOTE: 9 ref.
DOCUMENT TYPE: Journal Article ISSN: 0042-7934
LANGUAGE: Dutch
The **Food** Micromodel **computer model** for **prediction** of survival, growth and death of foodborne **pathogens** in relation to temp., pH, salt (or aw) and, optionally, preservatives is described. Examples of applications of this **model** are discussed, including product and process development, assessment of storage and **distribution** systems, and **prediction** of effects of time/temp. regimes on survival of **pathogens** in foods. (AJDW)
DESCRIPTORS (HEADINGS): **Pathogens ; Food safety**
DESCRIPTORS: **MODELLING** ; FOODS
GENERAL DESCRIPTORS: Microorganisms
SECTION HEADINGS: Hygiene & toxicology (SC=c, 9201-present)

```
Set      Items   Description
S1     6136786   CROP OR CROPS OR HARVEST OR FOOD OR VEGETABLE? OR MEAT? OR
             POTATO? OR AGRICULTUR?
S2    10635230   TRACK? OR TRACE? OR MONITOR? OR MODEL? OR SIMULAT? OR PRED-
             ICT? OR FORECAST? OR SURVEILL?
S3     6401001   SPREAD? OR SUPPLY()CHAIN? OR DISTRIBUT? OR FLOW? ? OR ROUT-
             E?
S4    10529512   DISEASE? OR ILLNESS? OR ANTHRAX? OR PLAGUE? OR CONTAMINANT?
              OR POISON? OR PATHOGEN? OR SMALLPOX?
S5       14905   S1 AND S2 AND S3 AND S4
S6        2015   S1(2N)S4 AND S5
S7       64506   BIOTERROR? OR BIOLOGICAL()(WEAPON? OR WARFARE? OR TERROR?)
             OR FOOD()(SECUR? OR SAFE?)
S8        2192   S2 AND S3 AND S7
S9        1851   S1 AND S8
S10        900   S4 AND S9
S11       7837   S2(5N)S3(5N)S4
S12         48   S10 AND S11
S13         33   RD (unique items)
S14         22   S13 NOT PY>2002
File   5:Biosis Previews(R) 1969-2004/Aug W1
         (c) 2004 BIOSIS
File   6:NTIS 1964-2004/Aug W1
         (c) 2004 NTIS, Intl Cpyrght All Rights Res
File  10:AGRICOLA 70-2004/Jun
         (c) format only 2004 The Dialog Corporation
File  34:SciSearch(R) Cited Ref Sci 1990-2004/Aug W1
         (c) 2004 Inst for Sci Info
File  50:CAB Abstracts 1972-2004/Jul
         (c) 2004 CAB International
File  65:Inside Conferences 1993-2004/Aug W1
         (c) 2004 BLDSC all rts. reserv.
File  94:JICST-EPlus 1985-2004/Jul W2
         (c)2004 Japan Science and Tech Corp(JST)
File  98:General Sci Abs/Full-Text 1984-2004/Jul
         (c) 2004 The HW Wilson Co.
File  99:Wilson Appl. Sci & Tech Abs 1983-2004/Jul
         (c) 2004 The HW Wilson Co.
File 143:
File 144:Pascal 1973-2004/Jul W4
         (c) 2004 INIST/CNRS
File 203:AGRIS 1974-2004/Jun
         Dist by NAL, Intl Copr. All rights reserved
File 235:AGROProjects 1990- 2004/Q3
         (c) 2004 PJB Publications,Ltd.
File 266:FEDRIP 2004/Jun
         Comp & dist by NTIS, Intl Copyright All Rights Res
File 306:Pesticide Fact File 2003/Sep
         (c) 2003 BCPC
File 357:Derwent Biotech Res. 1982-2004/Aug W2
         (c) 2004 Thomson Derwent & ISI
File 434:SciSearch(R) Cited Ref Sci 1974-1989/Dec
         (c) 1998 Inst for Sci Info
```

14/3,K/1 (Item 1 from file: 5)
DIALOG(R)File 5:Biosis Previews(R)

0010959885 BIOSIS NO.: 199799593945
Surveillance **of foodborne** disease : **I. purposes and types of** surveillance **systems and networks**
AUTHOR: Guzewich John J; Bryan Frank L (Reprint); Todd Ewen C D
AUTHOR ADDRESS: Food Safety Consultation Training, 8233 Pleasant Hill Rd., Lithonia, GA 30058, USA**USA
JOURNAL: Journal of Food Protection 60 (5): p555-566 1997 1997
ISSN: 0362-028X
DOCUMENT TYPE: Article; Literature Review
RECORD TYPE: Abstract
LANGUAGE: English

Surveillance **of foodborne** disease : **I. purposes and types of** surveillance **systems and networks**

ABSTRACT: This is the first part of a four-part series on foodborne **disease surveillance** . Although these articles are primarily built on expertise gained within North America, the substance is of value to any community or country wishing to initiate or improve its **surveillance** system. Foodborne **disease surveillance** is necessary for preventing further **spread** of foodborne **disease** and includes identifying and controlling outbreaks at the time they are occurring; gathering data on incidence of these **diseases** and prevalence of their etiologic agents, vehicles, and reservoirs; identifying factors that led to the...

...data bank for HACCP systems and risk assessments; estimating health and economic impacts of foodborne **diseases** ; and providing information upon which to base rational **food safety** program goals and priorities. Reports of outbreaks by local health agencies to regional and, then, national agencies responsible for **disease surveillance** , laboratory isolations of certain foodborne **pathogens** from human beings, sentinel community studies, and hazard **surveillance** are the types of foodborne **disease surveillance** activities that are used to varying extents in Canada and the U.S. In recent years, some national **surveillance** reports have been collated internationally in Europe and Latin America. **Surveillance** at local, state/provincial, national, and international levels must be coordinated for effective and rapid transfer of data. Computer software can assist investigation and management of the information submitted through **surveillance** networks. Information summarized on individual reports usually includes (a) location of the event, (b) clinical...

...report should be subjected to critical review before classifying it into the various categories of **surveillance** data. Such a review would also be useful when comparing **surveillance** data from different places and intervals. Highlights of individual reports are tabulated as line listings that are the direct sources of **surveillance** data, which are the subject of the second and third parts of this series.
DESCRIPTORS:
MISCELLANEOUS TERMS: ... **food** industry...

...FOODBORNE **DISEASE** **SURVEILLANCE** ; ...

... **SURVEILLANCE** SYSTEMS

14/3,K/2 (Item 1 from file: 6)
DIALOG(R)File 6:NTIS

2243866 NTIS Accession Number: PB2002-108395/XAB
Generic HACCP Model **for Irradiated, Raw** Meat **and Poultry Products**
Food Safety and Inspection Service, Washington, DC.
Corp. Source Codes: 101949000
Report No.: HACCP-8
May 1999 50p
Languages: English
Journal Announcement: USGRDR0225
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NTIS Prices: PC A04/MF A01

Generic HACCP Model **for Irradiated, Raw** Meat **and Poultry Products**
... the occurrence of problems by assuring that controls are applied at any point in a **food** production system where hazardous or critical situations could occur. Hazards include biological, chemical, or physical contamination of **food** products. The **Food Safety** and Inspection Service (FSIS) published a final rule in July 1996 mandating that HACCP be implemented as the system of process control in all inspected **meat** and poultry plants. As part of its efforts to assist establishments in the preparation of plant-specific HACCP plans, FSIS determined that a generic **model** for each process defined in the regulation would be made available for use on a voluntary basis by inspected establishments. This generic **model** is designed for use with the process subcategory: Irradiated, raw product.
Descriptors: **Meat** industry; *Irradiation; *Inspection; **Contaminants** ; Processing; **Food safety** ; **Flow** charts; **Models** ; Poultry; **Food** industry

14/3,K/5 (Item 1 from file: 10)
DIALOG(R)File 10:AGRICOLA

3848468 11083051 Holding Library: AGL
Poultry food **assess risk** model **(Poultry FARM) / Thomas P. Oscar**
Oscar, Thomas P.
United States. Agricultural Research Service. Eastern Regional Research Center. Microbial Food Safety Research Unit.
Version 2.0.
Poultry FARM
Princess Anne, MD : USDA, ARS, ERRC, Microbial Food Safety Research Unit, [2000?]
1 computer disk ; 3 1/2 in. + 1 sheet.
DNAL CALL NO: aRA601.5 .O83 2000
Language: English

Poultry food **assess risk** model **(Poultry FARM) / Thomas P. Oscar**
A collection of computer **spreadsheet models** that **predict** the exposure and response of consumers to human bacterial **pathogens** of poultry origin. Contains one **simulation model** and four **predictive models** . Provides poultry companies and regulatory agencies with computer **models** that assist them in making **food safety** decisions that impact public health.
DESCRIPTORS: Foodborne **diseases** ; **Food** ...
...Food contamination;
Section Headings: Q203 **FOOD** CONTAMINATION AND TOXICOLOGY-POULTRY; Q103 **FOOD** PROCESSING-POULTRY PRODUCTS

14/3,K/8 **(Item 3 from file: 34)**
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci

03608641 Genuine Article#: PR143 No. References: 8
Title: DEVELOPING AND DISTRIBUTING **USER-FRIENDLY APPLICATION SOFTWARE**
Author(s): BUCHANAN RL
Corporate Source: USDA ARS,EASTERN REG RES CTR,MICROBIAL FOOD SAFETY RES UNIT,600 E MERMAID LANE/PHILADELPHIA//PA/19118
Journal: JOURNAL OF INDUSTRIAL MICROBIOLOGY, 1993, V12, N3-5 (FAL), P 251-255
ISSN: 0169-4146
Language: ENGLISH Document Type: ARTICLE (Abstract Available)

Title: DEVELOPING AND DISTRIBUTING **USER-FRIENDLY APPLICATION SOFTWARE**
Abstract: The adoption of new techniques in **predictive** microbiology by the **food** industry will ultimately be dependent on the development of user-friendly application software that makes it easy for non-research personnel to employ the mathematical **models** . Such applications should be an integral part of projects in **predictive** microbiology. Recommendations related to the architecture, speed, protection, testing, and **distribution** of application software are presented based on our experience in developing and **distributing** the 'Microbial **Food Safety Pathogen Modeling** Program.'
...Identifiers--SODIUM-CHLORIDE; ANAEROBIC GROWTH; AEROBIC GROWTH; TEMPERATURE; **MODEL**; PH; NITRITE
Research Fronts: 92-0633 002 (SQUARE ROOT **MODEL** ; BACTERIAL-GROWTH CURVES; VARIABLE TEMPERATURES; **PREDICTIVE** MICROBIOLOGY; THERMAL REQUIREMENTS)

14/3,K/18 (Item 9 from file: 98)
DIALOG(R)File 98:General Sci Abs/Full-Text

03760152 H.W. WILSON RECORD NUMBER: BGSI98010152 (USE FORMAT 7 FOR FULLTEXT)
Quantitative risk assessment: an emerging tool for emerging foodborne pathogens .
Lammerding, Anna M
Paoli, Greg M
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 483-7
SPECIAL FEATURES: bibl ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 3453

(USE FORMAT 7 FOR FULLTEXT)
Quantitative risk assessment: an emerging tool for emerging foodborne pathogens .

ABSTRACT: New challenges to the safety of the **food** supply require new strategies for evaluating and managing **food safety** risks. Changes in **pathogens** , **food** preparation, **distribution** , and consumption, and population immunity have the potential to adversely affect human health. Risk assessment offers a framework for **predicting** the impact of changes and trends on the provision of safe **food** . Risk assessment **models** facilitate the evaluation of active or passive changes in how foods are produced, processed, **distributed** , and consumed. Reprinted by permission of the publisher.

TEXT:

The changing epidemiology of foodborne **diseases** is a result of complex interactions and changes in **pathogens** , foods, **food distribution** , **food** consumption, and population immunity (1-3). **Predicting** the impact of a trend in one part of the **food** continuum presupposes understanding of the whole system. Aspects of the **food** processing and **distribution** system can amplify or attenuate the trend as it grows into a potential health hazard. While a full understanding of **pathogen** contamination, infection, and survival is difficult, a systematic approach to assessing the impact of the **pathogen** on health may improve the quality of public health decisions (4,5).

Quantitative risk assessment is a possible approach for designing programs to address emerging foodborne **diseases** . The use of risk assessment in environmental toxicology illustrates the potential advantages of applying quantitative...
...combined to represent a cause-and-effect chain from the prevalence and concentration of the **pathogen** to the probability and magnitude of health effects. In risk assessment, risk consists of both the probability and impact of **disease** . In this way, risk reduction can be achieved in either dimension--by reducing the probability of **disease** or by reducing its severity.

HAZARD IDENTIFICATION

In hazard identification, an association between **disease** and the presence of a **pathogen** in a **food** is documented. The information may describe conditions under which the **pathogen** survives, grows, causes infection, and dies. Epidemiologic and **surveillance** data, challenge testing, and scientific studies of **pathogenicity** also contribute information. Data collected during hazard identification are later used in exposure assessment, where the impact of processing, **distribution** , preparation, and consumption of the **food** are incorporated.

EXPOSURE ASSESSMENT

Exposure assessment describes the pathways through which a **pathogen** population is introduced, **distributed** , and challenged in the production,

distribution , and consumption of **food** . This step differs from hazard identification in that it describes a particular **food** -processing pathway. Depending on the scope of the risk assessment, exposure assessment can begin with **pathogen** prevalence in raw materials (e.g., a "farm-to-fork" risk assessment), or it can begin with the description of the **pathogen** population at subsequent steps (e.g., as input to a **food** -processing step). In any case, the intent of risk assessment is to **track** the **pathogen** population and estimate the likelihood of its being ingested by the consumer. By completing the...

...DOSE-RESPONSE ASSESSMENT
Dose-response assessment is used to translate the final exposure to a **pathogen** population into a health response in the population of consumers. This step is very difficult because of the shortage of data on **pathogen** -specific responses and because those responses depend on the immune status of the host (consumer...

...burden and provide rapid responses to "what-if" questions using alternate assumptions and situations. Current **spreadsheet** applications and available "add-ins" allow generation of complicated probabilistic **models** that had previously only been available through expensive custom software.

RISK ASSESSMENT IN ENVIRONMENTAL TOXICOLOGY...

...as the predominant paradigm for describing the public health consequences of human exposure to environmental **contaminants** (8). Within this paradigm, existing situations are measured and compared according to a measure of...

...effectiveness of various regulatory programs is increasingly required on the basis of risk reduction. Microbial **food** **safety** , as a relative latecomer to the field of risk assessment, can take advantage of its an emerging tool in the field of microbial **food** and water safety (9-12). Recognizing the deficiencies of current approaches to evaluating the risk for human **illness** from **pathogens** in **food** , the Council for **Agricultural** Science and Technology recommended that risk assessment provide the basis for establishing **food** **safety** priorities and policies (5). Because of recent initiatives advocating the widespread implementation of Hazard Analysis...

...in a risk assessment) is the only acceptable basis for barriers to international trade in **food** (15-18). However, one of the most important benefits in the adoption of quantative risk assessment is improved understanding of the many factors that determine the safety of the **food** supply.

Some resistance to the adoption of risk assessment is likely. Good manufacturing practices and...

...on investment in producing a quantitative risk assessment may not be high for an individual **food** company with a very conservative production process. However, good manufacturing practices and outbreak data are not particularly useful in **predicting** the impact of new products, newly recognized **pathogens** , and changes in **food** processing or in comparing international **food** systems. Whether changes in the **food** supply are planned (as in refocused inspection systems and minimally processed foods) or are occurring passively (as in changed **pathogens** , demographics, and consumer behavior), tools are required to assemble the information that describes the impact...

...is a place for all the data from diverse information gathering activities relevant to microbial **food** **safety** . Recent analyses of pasteurized liquid egg (19) and ground beef contamination (20) incorporated evidence from farm-based studies of **pathogen** prevalence, technology assessments comparing decontamination methods, process-specific parameters of lot size and raw material mixing, growth and death **models** from

predictive microbiology, **monitoring** studies of transportation and retail temperature control, and studies of consumption amounts and cooking preference...

...designing the quantitative risk assessment process as an intelligent information bank, we can develop a **model** to accommodate the breadth of available information. The **model** provides a focus for discussions among workers from diverse disciplines: farmers, veterinarians, **food** -processing experts, microbiologists, and consumer behavior experts. The **model** also allows for consideration and comparison of control strategies for which experimentation would be very...

...impact, for example, of an aging population or a shift in cooking practices can be **simulated** by a variety of assumptions that reflect the extent of the change. By placing all...

...of proposed research.

The most obvious users for quantitative risk assessment as applied to microbial **food safety** are agencies responsible for **food** inspection, **disease surveillance** , and **food** standards. These agencies have the most to gain from **models** that incorporate existing and new data, capture knowledge of the relevant features of the **food** processing and **distribution** continuum, and capture knowledge of the variability in consumer behavior and immune system responses. If **models** are constantly updated and improved, decisions made to research, **monitor** , and control foodborne **pathogens** can be made with information that lends itself to multidisciplinary discussion and best describes what is currently known and unknown. Without such a **model** , there is little common ground for the type of collaboration often advocated for addressing the inherent complexity of foodborne **disease** .

RISK ASSESSMENT CASE EXAMPLES

Two case examples illustrate the prospects of using risk assessment to support decisions regarding emerging foodborne **diseases** .

ESCHERICHIA COLI O157:H7 IN GROUND BEEF

A **model** of E. coli O157:H7 in ground beef has been developed to support comparative assessment of control strategies (20). The **model** describes the **pathogen** population from the production of ground beef (including carcass processing) to consumer cooking and consumption. The variability and uncertainty in the **model** are accommodated through the use of probabilistic representations for many of the parameters. To generate a representative **distribution** of risk, the **model** is **simulated** many times with different values selected from the probability **distributions** . This is a technique known as Monte Carlo **simulation** (20-22).

While the direct output of the **model** is a **distribution** of health risk from eating ground beef hamburger patties, a more important use of the **model** is to describe the changes in health risk associated with changes in various parameters. By changing parameters describing, for example, **pathogen** prevalence and concentration in raw material, temperature abuse in transportation and retail, consumer cooking preference, infectious dose, and size of susceptible populations, we can study the impact of trends in **disease** risk factors. Because this **model** includes the farm-to-fork continuum, it is possible to assess the efficacy of interventions...

...of improved data at different points in the process can be estimated.

TOXOPLASMOSIS

A probabilistic **model** describing the incidence of toxoplasmosis was generated (23). While this **model** did not begin at the raw material level, valuable insights were gained in studying the...

...treated with certain drug therapies, the infection may have a smaller impact.

With such a **model** , the impact of varying risk factors can be studied. Since the most serious consequences of a function of age. The

protection offered by prior infection complicates **disease** therapy; a reduction in exposure to T. gondii could increase incidence of congenital toxoplasmosis by...

...to the complexities of the population immunity profile, various trends in risk factors can be **simulated** , such as trends in cat ownership, consumption of implicated products, and the age **distribution** of pregnancy. The emergence of toxoplasmosis as one of the leading causes of death in...

...strategies (e.g., education and screening programs designed for pregnant women) can be compared to **food** -processing strategies intended to reduce overall exposure.

The **model** of T. gondii infection provides insight into the importance of detailed hazard identification to understand the complex mechanisms of **disease** , exposure **modeling** to understand the time-dependent nature of exposure, and intervention **modeling** to understand the potential negative consequences of a reduction in overall exposure. Moreover, the results...

...unlikely that a sound decision could be made without a full microbial risk assessment involving **modeling** of the complex nature of population immunity and exposure.

CONCLUSIONS

One of the key benefits of quantitative risk assessment is the development of **models** describing the complex nature of **pathogen** populations in the **food** supply. Improved understanding of the efficacy of **pathogen** reduction is the most important side effect of this approach. Studies assessing the health impact of a foodborne **pathogen** often include extensive documentation of **pathogen** levels at unconnected points in the **food** and consumer pathway. In contrast, a microbial risk assessment based on a **model** provides a repository of knowledge describing health risk outcomes and control strategies. The **model** improves with each new related study and each critical review as more and more relevant...

...the system is already available in which assumptions and proposed interventions can be tested.

Initially, **models** can be expected to be crude. However, as a base for discussion, a **model** can be very effective at soliciting input from experts in the **food** industry and the public health community. Input from epidemiologists, microbiologists, and industry safety managers can be merged into the **model** until it represents the best available understanding of the interacting features of the **food** supply and their effect on the **distribution** of health risk. Once the **model** has been developed, the impact of various control strategies and trends can be **simulated** . Our current inability to compare control strategies at different points of the **food supply chain** is evidence of the need for a system-level understanding that will improve decision-making capacity.

Decisions to address foodborne **pathogens** cannot wait for scientific certainty. Large degrees of uncertainty require that decisions be made with ...

...is no excuse for not making the best decision on the basis of available information. **Model** -based quantitative risk assessment can provide the decision-maker additional insights not typically evident in...

...meal" considerations of data. The ability to represent the essentially probabilistic nature of emerging foodborne **disease** is another risk assessment attribute not typically achieved by traditional approaches.

Many gains in decision support can be achieved through **model** -based risk assessment. Given that many current concerns are focused on emerging **pathogens** , it may be timely to adopt risk assessment as a tool that is well equipped for studying changes and interventions in the race against **pathogens** .

Added material

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REFERENCES

1. Altekruse SF, Cohen ML, Swerdlow DL. Emerging foodborne **diseases** . Emerg Infect Dis 1997;3:285-93.

2. Hedberg CW, MacDonald KL, Osterholm MT. Changing epidemiology of **food** -borne **disease** : a Minnesota perspective. Clin Infect Dis 1994;18:671-82.

3. Smith JL, Fratamico PM. Factors involved in the emergence and persistence of **food** -borne **diseases** . Journal of **Food** Protection 1995;58:696-708.

4. Rodricks JV. Risk assessment, the environment, and public health...

...Foegeding PM, Roberts T, Bennett JM, Bryan FL, Cliver DO, Doyle MP, et al. Foodborne **pathogens** : risks and consequences. Ames (IA): Council for **Agricultural** Science and Technology (CAST) 1994; Task Force Report No.:122.

6. National Research Council. Risk...

...CP, Rose JB, Haas CN. Sensitive populations: who is at the greatest risk? Int J **Food** Microbiol 1996;30:113-23.

8. Commission on Risk Assessment and Risk Management. Framework for...

...The Commission; 1997.

9. Jaykus L-A. The application of quantitative risk assessment to microbial **food** **safety** risks. Crit Rev Microbiol 1996;22:279-93.

10. Rose JB, Sobsey MD. Quantitative risk assessment for viral contamination of shellfish and coastal waters. Journal of **Food** Protection 1993;56:1043-50.

11. ILSI Risk Science Institute **Pathogen** Risk Assessment Working Group. A conceptual framework to assess the risks of human **disease** following exposure to **pathogens** . Risk Anal 1996;16;841-8.

12. Rose JB, Haas CN, Gerba CP. Linking microbial...Buchanan RL, Montville TJ, editors. HACCP: an integrated approach to assuring the microbiological safety of **meat** and poultry. Trumbull (CT): **Food** Nutrition Press;1996.p.159-70.

13. Notermans S, Gallhoff G, Zwietering MH, Mead GC. The HACCP concept: specification of criteria using quantitative risk assessment. **Food** Microbiol 1995;12:81-90.

14. Buchanan RL. The role of microbiological criteria and risk assessment in HACCP. **Food** Microbiol 1995;12:421-4.

15. World Health Organization. Application of risk analysis to **food** standards issues. Report of the Joint FAO/WHO Expert Consultation 1995.WHO/FNU/FOS/Report No.95.3.

16. Hathaway S. Harmonization requirements under HACCP-based control systems. **Food** Control 1995;6:267-76.

17. Dawson RJ. The role of the Codex Alimentarius Commission in setting **food** standards and the SPS agreement implementation. **Food** Control 1995;6:261-5.

18. Hathaway SC, Cook RL. A regulatory perspective on the potential uses of microbial risk assessment in international trade. Int J **Food** Microbiol 1997;36:127-33.

19. Whiting RC, Buchanan RL. Development of a quantitative risk assessment **model** for Salmonella enteritidis in pasteurized eggs. Int J **Food** Microbiol 1997;36:111-26.

20. Cassin MH, Lammerding AM, Todd ECD, Ross W, McColl S. Quantitative risk assessment of Escherichia coli O157:H7 in ground beef hamburgers. Int J **Food** Microbiol. In press 1997.

21. Thompson KM, Burmaster DE, Crouch EAC. Monte Carlo techniques for ...

...1992;12:53-63.

22. Vose D. Quantitative risk analysis: a guide to Monte Carlo **simulation** **modelling** . New York: John Wiley & Sons, Inc.;1996.

23. Cassin MH, Lammerding AM, Paoli GM, McColl...

...Risk Analysis. p. 129.

24. Dixon BR. Prevalence and control of toxoplasmosis - a Canadian perspective. **Food** Control 1992;3:68-75.

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14/3,K/22 **(Item 1 from file: 266)**
DIALOG(R)File 266:FEDRIP

00311429
IDENTIFYING NO.: 1U54AI57168-01 AGENCY CODE: CRISP
Defense against Biowarfare and Emerging Infection Agents
PRINCIPAL INVESTIGATOR: LEVINE, MYRON M
ADDRESS: MLEVINE@MEDICINE.UMARYLAND.EDU UNIV OF MARYLAND SCH OF MED 685 W BALTIMORE ST, RM 480
PERFORMING ORG.: UNIVERSITY OF MARYLAND BALT PROF SCHOOL, BALTIMORE, MARYLAND
SPONSORING ORG.: NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS **DISEASES**
DATES: 2009/04/03 TO 2002/28/08 FY : 2003

SPONSORING ORG.: NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS **DISEASES**
...SUMMARY: Region consortium proposes to establish a Regional Center of Excellence for Biodefense and Emerging Infectious **Diseases** Research (RCE) whose theme is "Defense Against **Bioterror** and Emerging Infection Agents." The proposed Research Projects are: 1) **Anthrax** (new Bacillus anthracis antigens tested in animal **models** ; compounds to impede **anthrax** infection; mouse **model** for imaging germination and bacterial **distribution** ; and development of a mucosal live vector prime/parenteral boost **anthrax** vaccine); 2) Hemorrhagic Fever and other Emerging Viruses (identification/characterization of neutralizing human monoclonal antibodies...

... of neutralizing antibody and of vaccinia immune globulin; and development of a mouse ectromelia virus **model** of **smallpox** **pathogenesis** /prevention); 4) Tularemia (conjugate tularemia vaccine; study possible therapy of Francisella tularensis infection using reagents...

... individuals exposed to F. tularensis; and attenuated, live-vector tularemia vaccine); 5) Low-Dose Enteric **Pathogens** (role of type 1 Cryptosporidium parvum candidate genes in **pathogenesis** /susceptibility to infection as a prelude to vaccine development; Shigella dysenteriae 1 and EHEC vaccines; novel therapeutics for EHEC **disease** ; and diagnostics for detection of these **pathogens** in water, **food** , and environmental specimens); and 6) Public Health Response Research (needle-free immunization and vaccine-adjuvanting strategies; immunogenetics of human immune response to **smallpox** vaccine; and innovative diagnostic platforms for routine clinical use and in known or suspected **bioterror** events). Three Career Development Projects (to train the next generation of biodefense investigators) and four...

...and Process Development" (in collaboration with Aventis Pasteur Vaccines and Merck Vaccines); a Category A **Bioterror** Agent Clinical **Surveillance** Course; a "hands-on" course on working in BSL-3 facilities; and travel awards for...

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S3     1950561   SPREAD? OR DISTRIBUT? OR FLOW? ? OR ROUTE?
S4      212030   DISEASE? OR ILLNESS? OR ANTHRAX? OR PLAGUE? OR CONTAMINANT?
                 OR POISON? OR PATHOGEN? OR SMALLPOX?
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S6          25   S1(2N)S4 AND S5
S7           1   S6 AND IC=G06F?
S8           0   S1 AND S2 AND S4 AND SUPPLY()CHAIN?
S9         221   S1(2N)S2(3N)(S3 OR SUPPLY()CHAIN?)
S10          4   S9 AND (HEALTH? OR DISEASE? OR SICKNESS? OR BACTERIAL OR V-
                 IRAL OR TERRORIS? OR BIOTERROR? OR BIOLOGICAL()WARFARE?)
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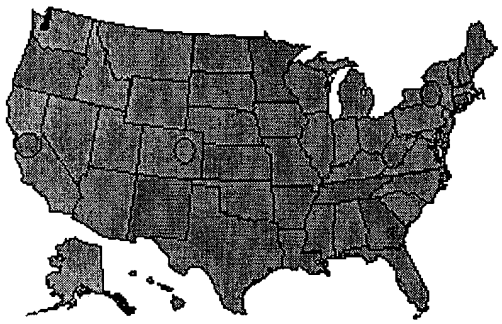
Foodborne Diseases Active Surveillance Network
CDC's Emerging Infections Program



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- Preliminary FoodNet Data on the Incidence of Infection with Pathogens Transmitted Commonly Through Food --- Selected Sites, United States, 2003
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S5       3663   S1 AND S2 AND S3 AND S4
S6        754   S1(2N)S4 AND S5
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S6        754   S1(2N)S4 AND S5
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S8        206   S6 AND S7
S9        188   RD (unique items)
S10       161   S9 NOT PY>2002
S11    173253   (S1 OR S4)(2N)S2
S12     33991   (S1 OR S4)(2N)S3
S13     73862   COMPUTER()(MODEL? OR SIMULAT? OR FORECAST? OR PREDICT?)
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Special Issue

Bioterrorism as a Public Health Threat

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The threat of bioterrorism, long ignored and denied, has heightened over the past few years. Recent events in Iraq, Japan, and Russia cast an ominous shadow. Two candidate agents are of special concern: smallpox and anthrax. The magnitude of the problems and the gravity of the scenarios associated with release of these organisms have been vividly portrayed by two epidemics of smallpox in Europe during the 1970s and by an accidental release of aerosolized anthrax from a Russian bioweapons facility in 1979. Efforts in the United States to deal with possible incidents involving bioweapons in the civilian sector have only recently begun and have made only limited progress. Only with substantial additional resources at the federal, state, and local levels can a credible and meaningful response be mounted. For longer-term solutions, the medical community must educate both the public and policy makers about bioterrorism and build a global consensus condemning its use.

Until recently, biological terrorism had been little discussed or written about. Until recently, I had doubts about publicizing the subject because of concern that it might entice some to undertake dangerous, perhaps catastrophic experiments. However, events of the past 12 to 18 months have made it clear that likely perpetrators already envisage every possible scenario.

Four points of view prevalent among national policy circles and the academic community at various times have served to dismiss biological terrorism as nothing more than a theoretical possibility. 1) Biological weapons have so seldom been deployed that precedent would suggest they will not be used. 2) Their use is so morally repugnant that no one would deign to use them. 3) The science of producing enough organisms and dispersing them is so difficult that it is within the reach of only the most sophisticated laboratories. 4) Like the concept of a "nuclear winter," the potential destructiveness of bioweapons is essentially unthinkable and so to be dismissed. Each of these arguments is without validity.

Nations and dissident groups exist that have both the motivation and access to skills to selectively cultivate some of the most dangerous pathogens and to deploy them as agents in acts of terrorism or war. After the Gulf War, Iraq was discovered to have a large biological weapons program. In 1995, Iraq confirmed that it had produced, filled, and deployed bombs, rockets, and aircraft spray tanks containing *Bacillus anthracis* and botulinum toxin (1,2); its work force and technologic infrastructure are still wholly intact. Also in 1995, the Japanese cult, Aum Shinrikyo, released the nerve gas Sarin in the Tokyo subway. The cult also had plans for biological terrorism (3); included in its arsenal were large quantities of nutrient media, botulinum toxin, anthrax cultures, and drone aircraft equipped with spray tanks. Members of this group had traveled to Zaire in 1992 to obtain samples of Ebola virus for weapons development.

Of more recent concern is the status of one of Russia's largest and most sophisticated former bioweapons facilities, called Vector, in Koltsovo, Novosibirsk. Through the early 1990s, this was a 4,000-person, 30-building facility with ample biosafety level 4 laboratory facilities, used for the isolation of both specimens and human cases. Situated on an open plain surrounded by electric fences and protected by an elite guard, the facility housed the smallpox virus as well as work on Ebola, Marburg, and the hemorrhagic fever viruses (e.g., Machupo and Crimean-Congo). A visit in the autumn of 1997 found a half-empty facility protected by a handful of guards who had not been paid for months (P. Jahrling, pers. comm., 1998). No one can say where the scientists have gone, nor is there confidence now that this is the only storage site for smallpox virus outside the Centers for Disease Control and Prevention.

The number of countries engaged in biological weapons experimentation has grown from 4 in the 1960s to 11 in the 1990s (4). Meanwhile, the bombing of the World Trade Center and the Oklahoma City Federal Building have dramatized the serious problems even small dissident groups can cause.

A comprehensive review of the problems posed by biological terrorism and warfare has been published (5). Four observations deserve special note. First, biological terrorism is more likely than ever before and far more threatening than either explosives or chemicals. Second, official actions directed at the threat to the civilian population (less than 2 years in the making) have been only marginally funded and minimally supported (6). Third, preventing or countering bioterrorism will be extremely difficult. Recipes for making biological weapons are now available on the Internet, and even groups with modest finances and basic training in biology and engineering could develop, should they wish, an effective weapon (7) at little cost. Fourth, detection or interdiction of those intending to use biological weapons is next to impossible. Thus, the first evidence of such weapons will almost certainly be cases in hospital emergency rooms. Specialists in infectious diseases thus constitute the front line of defense. The rapidity with which they and emergency room personnel reach a proper diagnosis and the speed with which they apply preventive and therapeutic measures could spell the difference between thousands and perhaps tens of thousands of casualties. Indeed, the survival of physicians and health-care staff caring for the patients may be at stake. However, today few have ever seen so much as a single case of smallpox, plague, or anthrax, or, for that matter, would recall the characteristics of such cases. Few, if any, diagnostic laboratories are prepared to confirm promptly such diagnoses.

Of a long list of potential pathogens, only a handful are reasonably easy to prepare and disperse and can inflict sufficiently severe disease to paralyze a city and perhaps a nation. In April 1994, Anatoliy Vorobyov, a Russian bioweapons expert, presented to a working group of the National Academy of Sciences the conclusions of Russian experts as to the agents most likely to be used (8). Smallpox headed the list followed closely by anthrax and plague. None of these agents has so far effectively been deployed as a biological weapon, and thus no real world events exist to provide likely scenarios. However, we have had several well-documented smallpox importations into Europe over recent decades; two bear recounting.

Smallpox is caused by a virus spread from person to person; infected persons have a characteristic fever and rash. Virus infection invariably results in symptomatic disease. There are no mild, subclinical infections among unvaccinated persons. After an incubation period of 10 to 12 days, the patient has high fever and pain. Then a rash begins with small papules developing into pustules on day 7 to 8 and finally changing to scabs around day 12. Between 25% and 30% of all unvaccinated patients die of the disease. There was, and is, no specific treatment.

Until 1980, essentially all countries conducted vaccination programs of some sort, whether or not they had endemic disease (9). Until 1972, the United States mandated smallpox vaccination for all children at school entry, although the last cases had occurred in 1949, 23 years before. In the United Kingdom, four

standby hospitals were to be opened only if smallpox cases were imported, and in Germany, two state-of-the-art isolation hospitals were constructed in the 1960s specifically for the isolation of smallpox cases should they occur.

In 1962, the initial response of U.S. officials to the occurrence of a single case of smallpox illustrated extreme concern. That year, a young Canadian boy returned from Brazil, traveling by air to New York and by train to Toronto by way of Albany and Buffalo (10). Shortly after arrival in Toronto, he developed a rash and was hospitalized. In response to this single case, senior U.S. government officials seriously considered a plan of action that called for the border with Canada to be closed, for mass vaccination campaigns to be conducted in all cities along the route from New York through Albany, Syracuse, Rochester, and Buffalo, and for vaccination of all who had been in Grand Central Station on the day the Canadian boy was there. Sensibly, this plan was soon scrapped for more modest measures, albeit not without considerable debate.

The potential of aerosolized smallpox to spread over a considerable distance and to infect at low doses was vividly demonstrated in an outbreak in Germany in 1970 (11). That year, a German electrician returning from Pakistan became ill with high fever and diarrhea. On January 11, he was admitted to a local hospital and was isolated in a separate room on the ground floor because it was feared he might have typhoid fever. He had contact with only two nurses over the next 3 days. On January 14 a rash developed, and on January 16 the diagnosis of smallpox was confirmed. He was immediately transported to one of Germany's special isolation hospitals, and more than 100,000 persons were promptly vaccinated. The hospital had been closed to visitors because of an influenza outbreak for several days before the patient was admitted. After the diagnosis of smallpox, other hospital patients and staff were quarantined for 4 weeks and were vaccinated; very ill patients received vaccinia-immune globulin first. However, the smallpox patient had had a cough, a symptom seldom seen with smallpox; coughing can produce a large-volume, small-particle aerosol like what might occur after its use as a terrorist weapon. Subsequently, 19 cases occurred in the hospital, including four in other rooms on the patient's floor, eight on the floor above, and nine on the third floor. Two were contact cases. One of the cases was in a visitor who had spent fewer than 15 minutes in the hospital and had only briefly opened a corridor door, easily 30 feet from the patient's room, to ask directions. Three of the patients were nurses, one of whom died. This outbreak occurred in a well-vaccinated population.

An outbreak in Yugoslavia in February 1972 also illustrates the havoc created even by a small number of cases. Yugoslavia's last case of smallpox had occurred in 1927. Nevertheless, Yugoslavia, like most countries, had continued populationwide vaccination to protect against imported cases. In 1972, a pilgrim returning from Mecca became ill with an undiagnosed febrile disease. Friends and relatives visited from a number of different areas; 2 weeks later, 11 of them became ill with high fever and rash. The patients were not aware of each other's illness, and their physicians (few of whom had ever seen a case of smallpox) failed to make a correct diagnosis.

One of the 11 patients was a 30-year-old teacher who quickly became critically ill with the hemorrhagic form, a form not readily diagnosed even by experts. The teacher was first given penicillin at a local clinic, but as he became increasingly ill, he was transferred to a dermatology ward in a city hospital, then to a similar ward in the capital city, and finally to a critical care unit because he was bleeding profusely and in shock. He died before a definitive diagnosis was made. He was buried 2 days before the first case of smallpox was recognized.

The first cases were correctly diagnosed 4 weeks after the first patient became ill, but by then, 150 persons were already infected; of these, 38 (including two physicians, two nurses, and four other hospital staff) were infected by the young teacher. The cases occurred in widely separated areas of the country. By the time of diagnosis, the 150 secondary cases had already begun to expose yet another

generation, and, inevitably, questions arose as to how many other yet undetected cases there might be.

Health authorities launched a nationwide vaccination campaign. Mass vaccination clinics were held, and checkpoints along roads were established to examine vaccination certificates. Twenty million persons were vaccinated. Hotels and residential apartments were taken over, cordoned off by the military, and all known contacts of cases were forced into these centers under military guard. Some 10,000 persons spent 2 weeks or more in isolation. Meanwhile, neighboring countries closed their borders. Nine weeks after the first patient became ill, the outbreak stopped. In all, 175 patients contracted smallpox, and 35 died.

What might happen if smallpox were released today in a U.S. city? First, routine vaccination stopped in the United States in 1972. Some travelers, many military recruits, and a handful of laboratory workers were vaccinated over the following 8 years. Overall, however, it is doubtful that more than 10% to 15% of the population today has residual smallpox immunity. If some modest volume of virus were to be released (perhaps by exploding a light bulb containing virus in a Washington subway), the event would almost certainly go unnoticed until the first cases with rash began to appear 9 or 10 days later. With patients seen by different physicians (who almost certainly had never before seen a smallpox case) in different clinics, several days would probably elapse before the diagnosis of smallpox was confirmed and an alarm was sounded.

Even if only 100 persons were infected and required hospitalization, a group of patients many times larger would become ill with fever and rash and receive an uncertain diagnosis. Some would be reported from other cities and other states. Where would all of these patients be admitted? In the Washington, D.C., metropolitan area, no more than 100 hospital beds provide adequate isolation. Who would care for the patients? Few hospital staff have any smallpox immunity. Moreover, one or two patients with severe hemorrhagic cases (which typically have very short incubation periods), who would have been hospitalized before smallpox was suspected, would have been cared for by a large, unprotected intensive care team.

What of contacts? In past outbreaks, contacts of confirmed or suspected cases numbered in the thousands, if not tens of thousands. What measures should or could be taken to deal with such numbers? Would patients be isolated as in Yugoslavia, and if so, where? Logistics could be simplified if rapid, easily used laboratory tests could confirm or rule out smallpox among suspected cases. At present, however, such tests are known only to scientists in two government laboratories.

An immediate clamor for mass vaccination (as in the outbreaks in Germany and Yugoslavia) can be predicted. U.S. stocks of smallpox vaccine are nominally listed at 15 million doses, but with packaging, the useful number of doses is perhaps half that number. How widely and quickly should this vaccine be used? Were vaccine to be limited strictly to close contacts of confirmed cases, comparatively few doses would be needed. However, the realities of dealing with even a small epidemic would almost certainly preclude such a cautious, measured vaccination effort. Vaccine reserves would rapidly disappear, and there is, at present, no manufacturing capacity to produce additional vaccine. If an emergency effort were made to produce new stocks of smallpox vaccine, many months to a year or more would be required.

What of anthrax, which has been so enthusiastically embraced by both Iraq and the Aum Shinrikyo? The organism is easy to produce in large quantity. In its dried form, it is extremely stable. The effect of aerosolized anthrax on humans once had to be inferred from animal experiments and the occasional human infection among workers in factories processing sheep and goat hides (12). It was clear that inhalation of anthrax is highly lethal. Just how lethal became evident in the 1979 Sverdlovsk epidemic (13).

In all, 77 cases were identified with certainty; 66 patients died. The actual total number of cases was probably considerably more than 100. The persons affected lived or worked somewhere within a narrow zone extending some 4 km south and east of a military bioweapons facility. An accidental airborne release of anthrax spores occurred during a single day and may well have lasted no more than minutes. Further investigations revealed anthrax deaths among sheep and cows in six different villages up to 50 km southeast of the military compound along the same axis as the human cases.

Of the 58 patients with known dates of disease onset, only 9 had symptoms within a week after exposure; some became ill as late as 6 weeks after exposure. Whether the onset of illness occurred sooner or later, death almost always followed within 1 to 4 days after onset. However, there appeared to be a somewhat higher proportion of survivors after the fourth week. This almost certainly resulted from the widespread application of penicillin prophylaxis and anthrax vaccine, both of which were distributed in mid-April throughout a population of 59,000.

Meselson and his colleagues, who documented this outbreak, calculate that the weight of spores released as an aerosol could have been as little as a few milligrams or as much as "nearly a gram." Iraq acknowledged producing at least 8,000 L of solution with an anthrax spore and cell count of 109/ml (1). The ramifications of even a modest-sized release of anthrax spores in a city are profound. Emergency rooms would begin seeing a few patients with high fever and some difficulty breathing perhaps 3 to 4 days after exposure. By the time the patients were seen, it is almost certain that it would be too late for antibiotic therapy. All patients would die within 24 to 48 hours. No emergency room physicians or infectious disease specialists have ever seen a case of inhalation anthrax; medical laboratories have had virtually no experience in its diagnosis. Thus, at least 3 to 5 days would elapse before a definitive diagnosis would be made.

Once anthrax was diagnosed, one would be faced with the prospect of what to do over the succeeding 6 to 8 weeks. Should vaccine be administered to those who might have been exposed? At present, little vaccine is available, and no plan exists to produce any for civilian use. Should antibiotics be administered prophylactically? If so, which antibiotics, and what should be the criteria for exposure? What quantity would be required to treat an exposed population of perhaps 500,000 over a 6-week period? Should one be concerned about additional infections resulting from anthrax spores subsequently resuspended and inhaled by others? Should everyone who has been anywhere near the city report to a local physician for treatment at the first occurrence of fever or cough, however mild? Undoubtedly, many would have such symptoms, especially in the winter; how can such symptoms be distinguished from the premonitory symptoms of anthrax that may proceed to death within 24 to 48 hours?

We are ill-prepared to deal with a terrorist attack that employs biological weapons. In countering civilian terrorism, the focus (a modest extension of existing protocols to deal with a hazard materials incident) has been almost wholly on chemical and explosive weapons. A chemical release or a major explosion is far more manageable than the biological challenges posed by smallpox or anthrax. After an explosion or a chemical attack, the worst effects are quickly over, the dimensions of the catastrophe can be defined, the toll of injuries and deaths can be ascertained, and efforts can be directed to stabilization and recovery. Not so following the use of smallpox or anthrax. Day after relentless day, additional cases could be expected, and in new areas.

The specter of biological weapons use is an ugly one, every bit as grim and foreboding as that of a nuclear winter. As was done in response to the nuclear threat, the medical community should educate the public and policy makers about the threat. We need to build on the 1972 Biological and Toxin Weapons Convention to strengthen measures prohibiting the development and production of biological weapons and to ensure compliance with existing agreements. In a broader sense, we need a strong moral consensus condemning biological weapons.

But this is not enough. In the longer term, we need to be as prepared to detect, diagnose, characterize epidemiologically, and respond appropriately to biological weapons use as to the threat of new and reemerging infections. In fact, the needs are convergent. We need at international, state, and local levels a greater capacity for surveillance; a far better network of laboratories and better diagnostic instruments; and a more adequate cadre of trained epidemiologists, clinicians, and researchers.

On the immediate horizon, we cannot delay the development and implementation of strategic plans for coping with civilian bioterrorism. The needed stocking of vaccines and drugs as well as the training and mobilization of health workers, both public and private, at state, city, and local levels will require time. Knowing well what little has been done, I can only say that a mammoth task lies before us.

D.A. Henderson is a distinguished service professor at the Johns Hopkins University, with appointments in the Departments of Health and Epidemiology, School of Hygiene and Public Health. Dr. Henderson directed the World Health Organization's global smallpox eradication campaign (1966-1977) and helped initiate WHO's global program of immunization in 1974. He also served in the federal government as deputy assistant secretary and senior science advisor in the Department of Health and Human Services.

References

1. Ekeus R. Iraq's biological weapons programme: UNSCOM's experience. Memorandum report to the United Nations Security Council; 1996 20 Nov; New York.
2. Zalinskas RA. Iraq's biological weapons: the past as future? JAMA 1997;278:418-24.
3. Daplan E, Marchell A. The cult at the end of the world. New York: Crown Publishing Group; 1996.
4. Roberts B. New challenges and new policy priorities for the 1990s. In: Biologic weapons: weapons of the future. Washington: Center for Strategic and International Studies; 1993.
5. Bioweapons and bioterrorism. JAMA 1997;278:351-70, 389-436.
6. Tucker JB. National health and medical services response to incidents of chemical and biological terrorism. JAMA 1997;285:362-8.
7. Danzig R, Berkowsky PB. Why should we be concerned about biological warfare? JAMA 1997;285:431-2.
8. Vorobyov A. Criterion rating as a measure of probable use of bio agents as biological weapons. In: Papers presented to the Working Group on Biological Weapons Control of the Committee on International Security and Arms Control, National Academy of Sciences; 1994 Apr; Washington.
9. Fenner F, Henderson DA, Arita I, Jezek Z, Ladnyi I. Smallpox and its eradication. Geneva: World Health Organization; 1988.
10. Epidemiologic report. Smallpox, Canada. MMWR Morb Mortal Wkly Rep 1962;11:258.
11. Wehrle PF, Posch J, Richter KH, Henderson DA. An airborne outbreak of smallpox in a German hospital and its significance with respect to other recent outbreaks in Europe. Bull World Health Organ 1970;4:669-79.
12. Brachman PS, Friedlander AM. Anthrax. In: Plotkin SA, Mortimer EA, editors. Vaccines. Philadelphia: WB Saunders; 1994.
13. Meselson M, Guillemin V, Hugh-Jones M, Langmuir A, Popova I, Shelokov A, et al. The Sverdlovsk anthrax outbreak of 1979. Science 1994;266:1202-8.

Emerging Infectious Diseases
National Center for Infectious Diseases
Centers for Disease Control and Prevention
Atlanta, GA

URL: http://www.cdc.gov/ncidod/EID/vol4no3/hendrsn.htm

Updated: 11/16/1998 15:43:05

03806868 H.W. WILSON RECORD NUMBER: BGSI98056868 (THIS IS THE FULLTEXT)

The threat of things biological.

VanderMeer, Dan C

Environmental Health Perspectives (Environ Health Perspect) v. 106 no6 (June '98) p. A280-A282
SPECIAL FEATURES: il ISSN: 0091-6765
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
RECORD TYPE: Abstract; Fulltext RECORD STATUS: Corrected or revised record
WORD COUNT: 2784

ABSTRACT: Biological threats and the way in which they can be addressed are discussed. The biological threats facing the world today include previously unknown infections such as the Ebola virus, HIV/AIDS, Lyme and Legionnaires' diseases, and deadly new strains of E. coli and Staphylococcus bacteria. Other threats are bacterial resistance to antibiotics and the development of biological warfare agents. Scientists, public health officials, policy makers, governments, and the public are trying to determine how to predict the spread of emerging infectious diseases and how to protect against their effects. Decisions must be made regarding which threats are the most urgent, how funding should be distributed for control and research, how to provide advice, how to establish health priorities, and how to design interventions to deal with the hazards.

TEXT:

Just as medical science developed the vaccines and drugs believed necessary to conquer infectious diseases such as smallpox, polio, measles, tuberculosis, whooping cough, and diphtheria, a new generation of risks to public health is emerging. Previously unknown infections such as the Ebola virus, HIV/AIDS, Lyme and Legionnaire's diseases, and deadly new strains of E. coli and Staphylococcus bacteria threaten public health worldwide. In addition, resistance to antibiotics is reaching epidemic proportions according to some scientists, and anthrax spores and botulism toxin have been produced and stockpiled for use as possible biological warfare agents.

In the face of these biological threats, scientists, the public, public health officials, policy makers, and governments are seeking answers to the questions of how to predict the spread of emerging infectious diseases and how to protect against their effects. In assessing the risk of biological agents, decisions will need to be made as to which of these threats to public health are most urgent, how to distribute funds for control and research, and how to provide advice, set public health priorities, and design interventions to deal with the newest versions of the oldest environmental hazards.

WHAT TYPE OF RISK?

The processes employed by scientists to assess and quantify risks differ depending on whether the threat is a chemical or physical hazard or a biological agent. Epidemiology, the study of the distribution and dynamics of diseases through human populations, provides a scientific basis for the evaluation of risk from biological agents. Most epidemics of infectious disease are characterized by acute symptoms that appear after relatively short incubation periods and can be reliably diagnosed from clinical signs and laboratory tests. Infectious disease epidemiologists can determine "attack rates," or the relative infectiousness and survival rates for infectious diseases. From these and other data, including the availability and effectiveness of treatments, they can also ascertain the severity of risk from uncontrolled disease outbreaks as compared to other infectious diseases. Epidemiologists also use mortality rates or incidence of severe disabilities to calculate "years of potential life lost" or "years of potential productivity lost" from debilitating infectious diseases such as maternal rubella infection or polio. Such estimates are used to support recommendations for funding of prevention programs for infectious diseases

and other public health problems.

Although epidemiology is also a valuable discipline in helping to characterize risks from long-term, chronic exposures to environmental chemical and physical hazards, there are fundamental differences between these exposures and effects and those associated with biological agents. Environmental chemical exposures are most often associated with chronic diseases with long incubation periods, and multiple etiologies. Their effects are not easily diagnosed in the early stages by either physical examination or laboratory studies. The risks to human health from hazardous chemical exposures often must be weighed against the benefits of economic and industrial development and an abundant food supply. Balancing risks with benefits implies the ability to accurately measure risks. If these risks are unacceptably high, regulations implementing engineering and other controls are enacted to manage them. Unlike most chemical hazards, disease-causing biological agents are generally viewed as naturally occurring entities with no associated benefit.

Throughout the 1960s and 1970s, public concern about environmental chemicals and radiation increased and worries about infectious disease declined. Federal agencies were created and given broad regulatory responsibilities for environmental, occupational, and consumer product safety. These agencies adopted a process called risk assessment to identify and quantify the health risks from exposures to chemical and physical agents. In March 1983, the National Academy of Sciences' National Research Council (NRC) published Risk Assessment in the Federal Government: Managing the Process. The study was commissioned by Congress to assist federal regulatory agencies in strengthening the reliability and objectivity of scientific assessments that provide a basis for regulatory policies applicable to chemical carcinogens and other nonbiological public health hazards. The report defined quantitative risk assessment as a four-step process:

* Hazard identification--the determination of whether a particular chemical is or is not causally liked to particular health effects;
* Dose-response assessment--the determination of the relationship between the magnitude of exposure and the probability of occurrence of the health effect in question;
* Exposure assessment--the determination of the extent of human exposure before or after the application of regulatory controls;
* Risk characterization--the description of the nature and often the magnitude of human risk, including attendant uncertainty.

The NRC report validated the fundamental principles of quantitative risk assessment used by federal regulatory agencies for environmental and occupational hazards, and risk assessment has become the fundamental tool used by environmental public health experts to estimate the magnitude of the threat to public health from chemical and physical hazards.

BIOLOGICAL RISK ASSESSMENT

Assessing the risk to human health from biological agents has taken a separate course. While federal research funding for cancers and other chronic diseases with presumed environmental etiologies increased, infectious and communicable disease programs and research have not fared as well. According to some critics, policy makers have assumed that modern vaccines, good sanitation, and food safety would continue to reduce the incidence of communicable diseases. To a limited extent, this optimism has been warranted, but it has failed to anticipate either the ability of biological agents to evade the armaments of modern medicine or the emergence of new, virulent infections that defy the best of modern medicine.

In 1973, smallpox virus escaped from a laboratory in London, causing widespread public alarm and initiating international efforts to assure that infectious agents in laboratories and research institutions are regulated and controlled. In the United States, the Centers for Disease Control and Prevention (CDC) developed guidelines for laboratory safety that include four levels of containment of human pathogens based on the magnitude of the risk of the agent to human health if released:

* Level 1--no or very low individual and community risk. The microorganism is unlikely to cause human or animal disease;

* Level 2--moderate individual risk and low community risk. The pathogen can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock, or the environment. Laboratory-acquired exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited;

* Level 3--high individual risk and low community risk. The pathogen usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available;

* Level 4--high individual risk and community risk. The pathogen usually causes serious human or animal disease and can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.

Under prevailing World Health Organization (WHO) convention, each member nation assigns biological agents to one of these categories based on such variables as pathogenicity, modes of transmission, levels of immunity in the local population, presence and control of vectors, and availability of preventive and therapeutic measures. In the United States, the CDC makes these determinations. The scientific process for classifying well-characterized pathogens such as smallpox is rather straightforward. But for emerging infectious diseases where data are limited, decisions must be based on preliminary epidemiological data, modeling, and a public health tradition that dictates the most conservative approach to unknown risks.

HIV/AIDS is one of the emerging infectious diseases for which policy makers and the public demanded estimates of risk to public health when very little data were available. According to Philip Cooley, a statistician and survey research expert at Research Triangle Institute in Research Triangle Park, North Carolina, once the retrovirus that causes AIDS had been identified and characterized, "Our priority was to model the spread of the infection so that public health officials could reliably publicize the risks of disease from various sexual and/or drug use behaviors." He adds, "These models were also critical to epidemiologists in making estimates of the spread of the HIV/AIDS epidemic in high-risk populations." The earliest HIV/AIDS risk models were based heavily on assumptions, and like the earliest assessments of chemical risks, they suffered from limited data characterizing the hazard or delineating the routes of exposure and dose response. However, as scientists tested the assumptions and as research provided more data, the models have became more accurate predictors. According to Cooley, the major value of modeling the spread of an emerging infectious disease through the population is in developing control strategies for emerging infectious diseases. For example, in the 26 July 1996 issue of Science, Sally Blower, a researcher in the department of biostatistics and epidemiology at the University of California at San Francisco, presents a theoretical framework for an eradication strategy for tuberculosis (TB) in developed and emerging nations. Blower modeled the transmission of TB in patients and derived estimates of the minimum treatment levels of patients and their contacts needed to eradicate TB. Cooley notes that "Blower has assimilated much of the seminal work in modeling the spread of infectious disease epidemics into a practical set of recommendations to the control of the worldwide tuberculosis epidemic." However, critics charge that while such models provide health officials with the elements to potentially reduce disease rates and control epidemics, they do not offer comparative quantifications of the magnitude of risks from biological agents.

Pathogens are selected as potential biological warfare and terrorism agents based on their high probability of causing a very high incidence of death or severe incapacitation. If such agents were used, scientists predict that the victims would overwhelm the health care delivery system and traditional public health interventions for protecting the general population. This reality is addressed in the August 1997 issue of the Journal of the American Medical Association, which is devoted entirely to the threat of biological warfare and biological terrorism. David Franz, a veterinary pathologist at the U.S. Army Medical Research Institute of Infectious Diseases at Ft. Detrick, Maryland, and lead author of the survey article on clinical recognition and management, included estimates prepared by the WHO in 1970 that, for example, 50 kg of Bacillus anthracis dispensed from an aircraft 20 km upwind of a city of 500,000 would kill 220,000

people. Franz's paper provides information on recognition, diagnosis, and treatment of the diseases caused by the pathogens most likely to be used by terrorists. Franz argues for a system of surveillance by physicians educated to recognize and report diseases caused by bioterrorism agents. The system would alert health officials quickly so that appropriate therapy could be initiated and the impact of a terrorist attack greatly reduced. He advocates education of all private physicians in the diagnosis and treatment of diseases caused by biological warfare and bioterrorism agents. But these measures have not yet taken place, in part because such programs would be expensive and present significant logistical difficulties. Measures such as creating a national surveillance system, manufacturing, stockpiling, and properly storing vaccines, and putting a vaccine delivery system in place to immediately immunize thousands of citizens face similar challenges.

TAKING MEASURES

The federal Anti-Terrorism Act authorized the CDC to issue risk-based regulations controlling the transfer and use of hazardous agents in the United States with the goal of preventing access for use in domestic or international terrorism. The CDC issued regulations in April 1997 that identified 24 infectious agents and 12 toxins that pose a significant risk to public health. These biological agents were selected based on the threat posed to human health from exposure, the contagiousness of the agent, the ease of methods by which the agent is transmitted through the population, and the availability and effectiveness of immunization and treatment. Both Franz and CDC experts point out that surveillance by physicians educated to recognize and report diseases caused by these restricted biological agents would alert health officials quickly so that appropriate therapy could be initiated and the impact of a terrorist attack greatly reduced.

Arnold Kaufmann, a medical epidemiologist recently retired from the CDC, and Martin Meltzer, a CDC health economist, writing in the April-June 1997 issue of the Journal of Emerging Infectious Diseases, modeled the impact of a terrorist attack using B. anthracis and estimated risks as measured by the economic costs. They reported a cost of $26.2 billion per 100,000 persons exposed. They argue that the nation cannot afford to not develop a system of surveillance, and establish a program to assure rapid, post-attack prophylaxis. Using an economic argument for interventions to protect human health from the risks of biological agents is a step toward harmonization of the differences between risk assessments for chemical and biological hazards. Another example of the convergence of the approaches to these problems and the scientific methods to assess risk can be found in recent proposals to improve food safety.

The World Trade Organization adopted the International Agreement on the Application of Sanitary and Phytosanitary Measures to give guidance to countries in developing consistent regulations to control the food-borne human and plant pathogens that may be imported on foods. Under the international covenant, these regulations must be risk-based. Anna Lammerding, chief of microbial food safety risk assessment for Health and Welfare Canada, proposes using the four-step process used in quantitative risk assessment for environmental chemicals as a "new strategy for evaluating and managing food safety risks that arise from changes in pathogens, food preparation, distribution, consumption, and population immunity that have the potential to adversely affect human health." Nell Ahl, director of the U.S. Department of Agriculture's (USDA) Office of Risk Assessment and Cost Benefit Analysis, compares and contrasts toxicological and chemical risk assessments developed over the past 30 years with the procedures used to assess risks from imported plant pests and livestock diseases, as well as food safety for human health. Ahl says, "Biological risk assessments present great challenges because of the variability of individual pathogens as well as the fact that the variability of individuals affected by these pathogens adds another level of complexity." She adds, "The USDA uses scenario or pathway analysis and probabilistic methods to trace the hazard from the initiating event to the occurrence of the hazard, making use of probability density functions to express what is known and what is not known about the movement of the hazard through the pathway." The USDA has not yet formally adopted these procedures, not have they become the standard for justifying the regulations controlling the

import of human and plant pathogens on foods and other agricultural products into the United States. Ahl wants to be sure that the four-step process delineated in the NRC report can be adapted in a scientifically rigorous manner for biological purposes. Lammerding is quite optimistic that the quantitative risk-assessment model for chemical hazards can be adapted. She and her colleagues are using it as the general approach to assessing risks from food-borne pathogens.

The 1983 NRC report concluded, "Dissatisfaction with the actions of federal regulatory agencies is often expressed as criticism of the conduct and administration of the risk assessment process. The committee believes that the basic problem in risk assessment is the sparseness and uncertainty of the scientific knowledge of the health hazard addressed, and this problem has no ready solution. The field has been developing rapidly and the greatest improvements in risk assessment result from acquisition of more and better data, which decreases the need to rely on inference and informed judgment." Clearly this statement is true today for both chemical and biological risk assessments. In particular, as recognition grows that both old and new infectious agents continue to threaten public health, assessing these risks is dependent on aggressive pursuit of scientific knowledge and a rational process to use this knowledge to quantitate these risks and to design effective interventions.

DESCRIPTORS:
Biological warfare; Risk; Environmental health; Emergency planning

Dialog Search 5 Aug 04

155 + EECOMP + ELECTRON + COMPSCI

?ds

Set	Items	Description
S1	16925928	MODEL? OR SIMULAT?
S2	107765	(FOOD OR PRODUCT OR CROP OR VEGETABLE OT FRUIT) (W) DISTRIBUT?
S3	108835	(FOOD OR PRODUCT OR CROP OR VEGETABLE OR FRUIT) (W) DISTRIBUT?
S4	14455	S1 AND S3
S5	510	S1 (3N) S3
S6	5	S5 AND CONTAMINAT?
S7	927510	CONTAMINAT? OR BIOSECURITY OR BIOTERRORISM
S8	5	S5 AND S7

?t s8/medium,k/all
>>>KWIC option is not available in file(s): 241
>>>"MEDIUM" is not a valid format name in file(s): 36

8/K/1 (Item 1 from file: 155)
DIALOG(R)File 155:MEDLINE(R)

13682798 PMID: 9371434
Regioselectivity of nitroglycerin denitration by flavoprotein nitroester reductases purified from two Pseudomonas species.
Blehert D S; Knoke K L; Fox B G; Chambliss G H
Department of Bacteriology, College of Agricultural and Life Sciences, University of Wisconsin, Madison 53706, USA.
Journal of bacteriology (UNITED STATES) Nov 1997, 179 (22) p6912-20, ISSN 0021-9193 Journal Code: 2985120R
Contract/Grant No.: 5T32GM08349; GM; NIGMS
Document type: Journal Article
Languages: ENGLISH
Main Citation Owner: NLM
Record type: Completed

...Pseudomonas capable of utilizing nitroglycerin (NG) as a sole nitrogen source were isolated from NG- **contaminated** soil and identified as Pseudomonas putida II-B and P. fluorescens I-C. While 9...

... dependent denitration reactions were consistent with a single enzyme being responsible for the in vivo **product distributions** . **Simulation** of the product formation kinetics by numerical integration showed that the P. putida enzyme produced...

... DNG, a 1.3-fold selectivity for the C-1 nitro group was determined. Comparable **simulations** of the **product distributions** from the P. fluorescens enzyme showed that NG was denitrated with a 4.6-fold...

8/K/2 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

02325583 110301373
Cosmetic preparedness (part II)
Geffken, Carl
Global Cosmetic Industry v170n2 PP: 12 Feb 2002
ISSN: 1523-9470 JRNL CODE: DCI
WORD COUNT: 659

...TEXT: event of product tampering, it will be critical to quickly identify the nature of any **contamination** , how it can be isolated, and how to keep the product secure from causing harm...

... about the source and identity of ingredients and packaging materials throughout the manufacturing process and **product distribution** . The **model** for documentation of each step in your process comes from the pharmaceutical industry and now...

8/K/3 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

08463178 SUPPLIER NUMBER: 17976177 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Banks waking up to Java as a model **for** product distribution . **(computer language) (Management Strategies)**
MacRae, Desmond
American Banker, v161, n28, p6A(2)
Feb 12, 1996
ISSN: 0002-7561 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 1350 LINE COUNT: 00108

Banks waking up to Java as a model **for** product distribution . **(computer language) (Management Strategies)**
... code. The applet contains code identifying it as a legitimate source of the information. Thus, **contamination** by viruses is automatically limited. But this claim will have to be well tested before...

8/K/4 (Item 1 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci

06287685 Genuine Article#: YG075 No. References: 44
Title: Regioselectivity of nitroglycerin denitration by flavoprotein nitroester reductases purified from two Pseudomonas species
Author(s): Blehert DS; Knoke KL; Fox BG; Chambliss GH (REPRINT)
Corporate Source: UNIV WISCONSIN,COLL AGR & LIFE SCI, DEPT BACTERIOL, RM 225 EB FRED HALL/MADISON//WI/53706 (REPRINT); UNIV WISCONSIN,COLL AGR & LIFE SCI, DEPT BACTERIOL/MADISON//WI/53706; UNIV WISCONSIN,GRAD SCH, INST ENZYME RES/MADISON//WI/53706; UNIV WISCONSIN,GRAD SCH, DEPT BIOCHEM/MADISON//WI/53706
Journal: JOURNAL OF BACTERIOLOGY, 1997, V179, N22 (NOV), P6912-6920
ISSN: 0021-9193 Publication date: 19971100
Publisher: AMER SOC MICROBIOLOGY, 1325 MASSACHUSETTS AVENUE, NW, WASHINGTON, DC 20005-4171
Language: English Document Type: ARTICLE (ABSTRACT AVAILABLE)

...Abstract: Pseudomonas capable of utilizing nitroglycerin (NG) as a sole nitrogen source were isolated from NG- **contaminated** soil and identified as Pseudomonas putida II-B and P. fluorescens I-C, While 9 ...

...dependent denitration reactions were consistent with a single enzyme being responsible for the in vivo **product distributions** . **Simulation** of the product formation kinetics by numerical integration showed that the P. putida enzyme produced...

...DNG, a 1.3-fold selectivity for the C-1 nitro group was determined. Comparable **simulations** of the **product distributions** from the P. fluorescens enzyme showed that NG was denitrated with a 4.6-fold...

8/K/5 (Item 1 from file: 144)
DIALOG(R)File 144:Pascal

13667292 PASCAL No.: 98-0375261
A decision support system for the prediction of microbial food safety and food quality
WIJTZES T; VAN'T RIET K; HUIS IN'T VELD J H J; ZWIETERING M H
Wageningen Agricultural University, Department of Food Technology and Nutrition Sciences, Wageningen, Netherlands; Utrecht University, School of Veterinary Medicine, Utrecht, Netherlands
Journal: International journal of food microbiology, 1998, 42 (1-2) 79-90
Language: English

... parameters. Food quality can be calculated as a function of fluctuating temperature in time. Several **food distribution** chains can be **simulated** in order to assess the influence of distribution chains on food quality. The described methods...

English Descriptors: Formulation; Manufacturing; Decision support system; Database; Foodstuff; Prediction; Quality; Safety; Biological **contamination** ; Simulation; Product development; Environmental factor

French Descriptors: Formulation; Fabrication; Systeme aide decision; Base donnee; Produit alimentaire; Prediction; Qualite; Securite; **Contamination** biologique; Simulation; Developpement produit; Facteur milieu

?

Dialog Search
6 Aug 04

?t s6/medium,k/all

6/K/1
DIALOG(R)File 98:General Sci Abs/Full-Text

03760611 H.W. WILSON RECORD NUMBER: BGSI98010611 (USE FORMAT 7 FOR FULLTEXT)
Impact of changing consumer lifestyles on the emergence/reemergence of foodborne pathogens.
Collins, Janet E
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 471-9
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 5341

(USE FORMAT 7 FOR FULLTEXT)

TEXT:
... and source of foodborne disease outbreaks and cases. CDC will use the data to identify **emerging foodborne pathogens** and monitor incidence of foodborne illness; FSIS will use the data to evaluate the effectiveness...with others, but they want to know that steps are taken during the processing and **distribution** of foods to reduce the likelihood of pathogen or other bacterial contamination.
According to Technomics...Agency. These responsibilities include oversight on the farm, in the processing facilities, during transportation and **distribution** (including food from foreign countries), and in

6/K/2
DIALOG(R)File 98:General Sci Abs/Full-Text

03760165 H.W. WILSON RECORD NUMBER: BGSI98010165 (USE FORMAT 7 FOR FULLTEXT)
Irradiation pasteurization of solid foods: taking food safety to the next level.
Osterholm, Michael T
Potter, Morris E
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 575-7
SPECIAL FEATURES: bibl ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 1938

(USE FORMAT 7 FOR FULLTEXT)

TEXT:
... residual risk for infection that remains after state-of-practice sanitation during production, harvest, processing, **distribution** , and preparation yields an unacceptable level of illness and death. In addition, the admonition to...vacuum created by this lack of leadership from public health. Presentations at the Conference on **Emerging Foodborne Pathogens** make it clear that new foodborne hazards are being stacked on top of old, unresolved...

6/K/3
DIALOG(R)File 98:General Sci Abs/Full-Text

03760157 H.W. WILSON RECORD NUMBER: BGSI98010157 (USE FORMAT 7 FOR FULLTEXT)
Identifying and controlling emerging foodborne pathogens **: research needs.**

Buchanan, Robert L
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 517-21
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 3023

(USE FORMAT 7 FOR FULLTEXT)
Identifying and controlling emerging foodborne pathogens : **research needs.**

TEXT:
... Because it requires substantial knowledge, HACCP cannot be expected to control unknown hazards, such as **emerging foodborne pathogens** . Therefore, controlling a new foodborne microbial threat requires moving the hazard as quickly as possible...normal controls? Does the pathogen grow in foods? Does the pathogen survive normal food processing, **distribution** , and preparation? How infectious/toxigenic is the pathogen? Are there subpopulations of consumers at increased...

...research. Little consideration has been given to how to assess and set research priorities for **emerging foodborne pathogens** . One attempt was provided as an appendix of the U.S. Pathogen Reduction Task Force...fax: 215-233-6445; e-mail: rbuchanan@arserrc.gov.
Table. Research data needed for most **emerging foodborne pathogens**

Research area	Knowledge gaps
Detection methods	Sampling and enrichment techniques
	Cultivating
	Biochemical/taxonomic char.
	Antibodies...

6/K/4
DIALOG(R)File 98:General Sci Abs/Full-Text

03760155 H.W. WILSON RECORD NUMBER: BGSI98010155 (USE FORMAT 7 FOR FULLTEXT)
Foodborne disease control: a transnational challenge.
Kaferstein, F. K
Motarjemi, Y; Bettcher, D. W
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 503-10
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 4499

(USE FORMAT 7 FOR FULLTEXT)

TEXT:
... and packaging to locations thousands of miles away. This multinational approach to food production and **distribution** and the progressive opening up of world markets have allowed the international food trade to...3 days, and the product was withdrawn from the market (12).
Because of global food **distribution** and worldwide travel, an international exchange of information on foodborne disease incidences and outbreaks and...inactivate bacterial agents; and cultural factors relating to consumers.

In addition, for some of the **emerging foodborne pathogens** , the sources of exposure are still not fully understood. Information on foodborne disease outbreaks provides...

6/K/5
DIALOG(R)File 98:General Sci Abs/Full-Text

03760153 H.W. WILSON RECORD NUMBER: BGSI98010153 (USE FORMAT 7 FOR FULLTEXT)
Communicating foodborne disease risk.
Fischhoff, Baruch
Downs, Julie S
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 489-95
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 3751

(USE FORMAT 7 FOR FULLTEXT)

TEXT:
... notice to deal with various crises, often involving baffling combinations of foods, pathogens, handling and **distribution** practices, dietary norms, and interactions with medical conditions and medications. Their response to this challenge...

...in lay understanding of risk. We explore here the implications for anticipating public response to **emerging foodborne pathogens** and offer a proposal for how an effective communication campaign might be organized.
Although risk communication research does not directly address **emerging foodborne pathogens** , it is compatible with the model of risk assessment that the food industry seems to...

...level (through practical measures), and communicating with the public about them.
Like many other risks, **emerging foodborne pathogens** are of primary concern to some specialists but one more thing to worry about for of patients, with a **distribution** of physical states (e.g., stroke risks) and values (e.g., time horizons). The analysis...labeling, warning, or communication strategy is chosen will leave some residual risk, with an uneven **distribution** depending on the heterogeneous sensitivities of the audience. Thus, the strategy reflects the authorities' notion...

...empirical testing is needed to determine whether communications fulfill the hopes placed in them (27). **Emerging foodborne pathogens** provide a particular challenge to safety communications--and a particular need for evaluation. Their novelty...

6/K/6
DIALOG(R)File 98:General Sci Abs/Full-Text

03760152 H.W. WILSON RECORD NUMBER: BGSI98010152 (USE FORMAT 7 FOR FULLTEXT)
Quantitative risk assessment: an emerging tool for emerging foodborne pathogens .
Lammerding, Anna M
Paoli, Greg M
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 483-7
SPECIAL FEATURES: bibl ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 3453

(USE FORMAT 7 FOR FULLTEXT)
Quantitative risk assessment: an emerging tool for emerging foodborne pathogens .

...ABSTRACT: require new strategies for evaluating and managing food safety risks. Changes in pathogens, food preparation, **distribution** , and consumption, and population immunity have the potential to adversely affect human health. Risk assessment...

TEXT:
... of foodborne diseases is a result of complex interactions and changes in pathogens, foods, food **distribution** , food consumption, and population immunity (1-3). Predicting the impact of a trend in one...

...the food continuum presupposes understanding of the whole system. Aspects of the food processing and **distribution** system can amplify or attenuate the trend as it grows into a potential health hazard...

...collected during hazard identification are later used in exposure assessment, where the impact of processing, **distribution** , preparation, and consumption of the food are incorporated.

EXPOSURE ASSESSMENT
Exposure assessment describes the pathways through which a pathogen population is introduced, distributed, and challenged in the production, **distribution** , and consumption of food. This step differs from hazard identification in that it describes a...existing and new data, capture knowledge of the relevant features of the food processing and **distribution** continuum, and capture knowledge of the variability in consumer behavior and immune system responses. If...

...through the use of probabilistic representations for many of the parameters. To generate a representative **distribution** of risk, the model is simulated many times with different values selected from the probability ...

...as Monte Carlo simulation (20-22).

While the direct output of the model is a **distribution** of health risk from eating ground beef hamburger patties, a more important use of the ...be simulated, such as trends in cat ownership, consumption of implicated products, and the age **distribution** of pregnancy. The emergence of toxoplasmosis as one of the leading causes of death in...

...available understanding of the interacting features of the food supply and their effect on the **distribution** of health risk. Once the model has been developed, the impact of various control strategies...

...be simulated. Our current inability to compare control strategies at different points of the food **supply chain** is evidence of the need for a system-level understanding that will improve decision-making...

6/K/7
DIALOG(R)File 98:General Sci Abs/Full-Text

03760145 H.W. WILSON RECORD NUMBER: BGSI98010145 (USE FORMAT 7 FOR FULLTEXT)
Emerging foodborne diseases: an evolving public health challenge.
Tauxe, Robert V
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (Oct./Dec. '97) p. 425-34
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 6991

(USE FORMAT 7 FOR FULLTEXT)

TEXT:
... or sporadic cases. Therefore, the sources of sporadic cases must

also be investigated and understood.

EMERGING FOODBORNE PATHOGENS

Substantial progress has been made in preventing foodborne diseases. For example, typhoid fever, extremely common...been identified during these investigations, including contamination during production and harvest, initial processing and packing, **distribution** , and final processing (Table 3). For example, fresh or inadequately composted manure is used sometimes ...of the illness syndrome, the potential hazard of that food, and the logical consistency of **distribution** of the suspect food and cases are essential.

The role of the regulatory agency laboratory is also affected by the new scenario. Because of the short shelf life and broad **distribution** of many of the new foods responsible for infection, by the time the outbreak is...manure,

bundling	lack of field sanitation
Initial processing	
Washing, waxing, sorting, boxing	Wash water, handling
Distribution	
Trucking	Ice, dirty trucks
Final processing	
Slicing, squeezing, shredding, peeling	Wash water, handling, cross-contamination...

6/K/8

DIALOG(R)File 98:General Sci Abs/Full-Text
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03544151 H.W. WILSON RECORD NUMBER: BGSI97044151 (USE FORMAT 7 FOR FULLTEXT)

Emerging foodborne diseases.

Altekruse, S. F
Cohen, M. L; Swerdlow, D. L
Emerging Infectious Diseases (Emerging Infect Dis) v. 3 (July/Sept. '97) p. 285-93
SPECIAL FEATURES: bibl il ISSN: 1080-6040
LANGUAGE: English
COUNTRY OF PUBLICATION: United States
WORD COUNT: 5717

(USE FORMAT 7 FOR FULLTEXT)

TEXT:

... in the last two decades has accompanied modern food industries' centralized production and large-scale **distribution** . The most prevalent serotypes, Salmonella serotype Enteritidis (SE), Salmonella Typhimurium, and Salmonella Heidelberg, account for...from 1970 to 1994 (21). Fresh produce is susceptible to contamination during growth, harvest, and **distribution** . The surface of plants and fruits may be contaminated by human or animal feces. Pathogens...

...from parent to child (29).

CHANGES IN INDUSTRY AND TECHNOLOGY

The trend toward greater geographic **distribution** of products from large centralized food processors carries a risk for dispersed outbreaks. When mass...

...illnesses may appear sporadic rather than part of an outbreak (32).

Industry consolidation and mass **distribution** of foods may lead to large outbreaks of foodborne disease. In 1985, an outbreak of...

...linked by common machinery (35), resulting in large flocks with common risk profiles. Large-scale **distribution** of shell eggs from infected flocks has caused outbreaks in which contaminated eggs were distributed... undercooked,

cross-
contaminated.

Table 2. Selected outbreaks in the United States 1988-1997, associated with **emerging foodborne pathogens** and factors for the emergence of these pathogens

Figure 1. Salmonella serotype Enteritidis as a...

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?ds

Set     Items   Description
S1          0   EMERGING (W) FOODBOURNE (W) PATHOGENS
S2         10   EMERGING (W) FOODBORNE (W) PATHOGENS
S3         10   RD (unique items)
S4      23706   DISTRIBUTION OR (SUPPLY()CHAIN)
S5          8   S3 AND S4
S6          8   RD (unique items)
?
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PLUS Search Results for S/N 10681581, Searched August 09, 2004

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